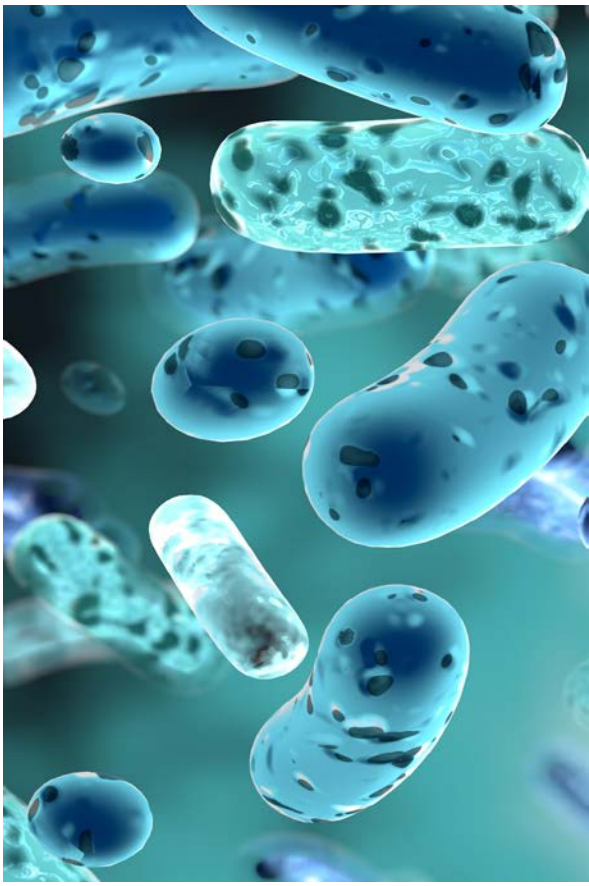
Probiotics - metabolic health and weight management

The potential of the Microbiome

Microbiome research has shown it is possible to affect outcomes in numerous diagnoses by modulating the microorganisms of the gut, and much research interest has been focused on the role of the microbiome in helping to tackle obesity. By first characterizing and understanding the microbial changes present in overweight and obese populations, researchers are then able to progress to interventional trials in order to understand how modulating the microbiome can affect obesity outcomes.



ADM'S INNOVATIVE MICROBIOME RESEARCH

ADM has a long history of conducting proprietary microbiome research, with an extensive library of pre-clinical and clinical trials to support our growing range of cutting-edge microbiome solutions.

Game Changer Probiotic Solutions

BPL1: A Cutting-Edge Biotic Solution

BPL1 (*Bifidobacterium animalis subsp. lactis* CECT 8145) is ADM's proprietary, award-winning probiotic strain with positive clinical tirals in relation to body mass index (BMI), waist circumference (WC), and visceral fat area.

WINNER: NutraIngredients Awards in 2020 as Ingredient of the Year in Weight Management

BPL1 at a Glance

Clinical trials have demonstrated beneficial effects of BPL1 in metabolic balance, metabolic health, better body shape, reduced waist circumference, decreased visceral fat area and reduced BMI

More than 9 years of R&D, including proprietary, patent protected science and human clinical trials

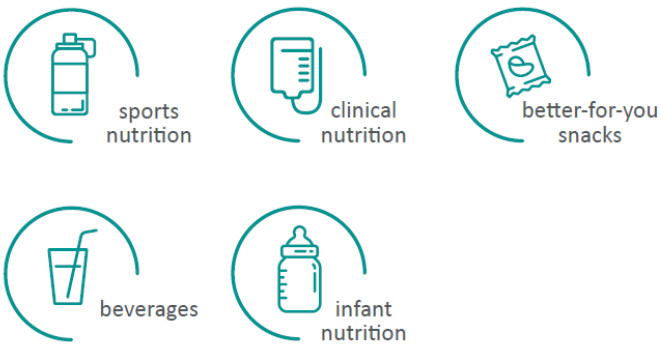
Cutting-edge pre-clinical and clinical Research, development and commercialization capabilities

Human origin strain protected by patent

More Applications. More Benefits

BPL1 is ideal for use in **dietary supplements** including drops, capsules, sachets and sticks, **and dairy products**, such as fresh milk and fermented milk.

BPL1 can also be incorporated into the following applications, under certain manufacturing and preservation conditions:



CLAIMS AND CERTIFICATIONS

- EU | QPS list
- Non-GMO
- Organic
- Gluten Free
- Kosher

Probiotic - metabolic health and weight management: Executive summary

ADM offers an effective solution focused in fat loss but also addressing various obesity-related factors, as oxidative stress and inflammation that act as a link to other pathologies.

Our strains...

***Bifidobacterium lactis* BPL1**	**→ Research showing positive results on reduction of BMI, waist circumference and abdominal visceral fat**
***Lactobacillus rhamnosus* CNCM I-4036**	**→ Research suggest positive anti-inflammatory properties**
***Lactobacillus rhamnosus* CECT 8361 (BPL15)**	**→ Research suggests positive antioxidant properties**
***Lactobacillus casei* CECT 9104 (BPL4)**	**→ Complementary and enhancing properties**

Introduction

According to the World Health Organization, an escalating global epidemic of obesity – globesity – is taking over in many parts of the world. Continued growth in the number of people who are overweight or obese is driving the need for effective, scientifically-validated interventions focused on weight management and improving metabolic health.

The causes of obesity are complex and multifactorial – and the treatments and solution options available are similarly diverse and wide ranging. In recent years, consumer trends have started shifting toward the implementation of adjunct therapies like probiotics. Current consumer insights show a clear need and demand for the development of new and innovative solutions to drive positive metabolic health outcomes & to assist with maintaining a healthy weight. Modulation of the microbiome offers consumers an exciting opportunity to influence health outcomes through every day choices. Therefore, microbiome modulation for improved metabolic health, body composition & weight management has the potential to represent a key breakthrough for today's consumers.

The probiotic industry can address this need but has been slow to develop use-specific strains and show probiotics can drive improvements in meaningful endpoints. To fill this gap in the market, ADM offers an effective, scientifically-researched intervention with its probiotic ***Bifidobacterium lactis* BPL1.**

In addition, **we have added 3 different strains (*Lactobacillus rhamnosus* CECT8361, *Lactobacillus rhamnosus* CNCM I-4036 and *Lactobacillus casei* CECT 9104)** in order to act as an adjuvant together with BPL1 to provide additional benefits. (Figure 1)

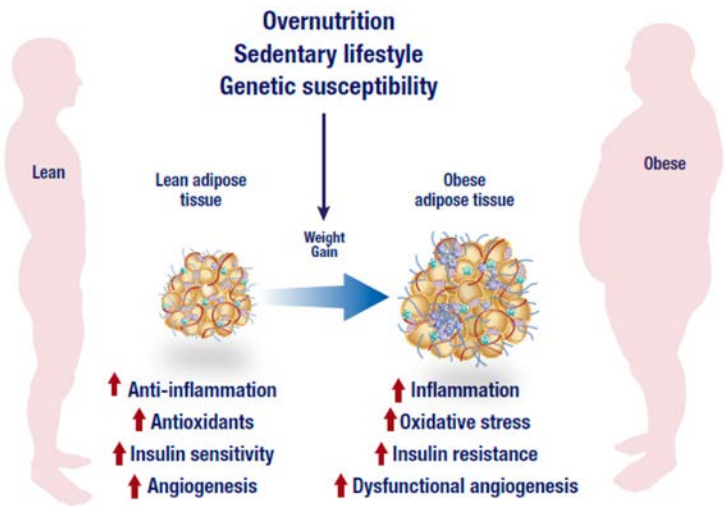


Fig1: Overnutrition, sedentary lifestyle and genetic susceptibility are the leading factors associated with the development of obesity. In addition to dysfunctional angiogenesis, **an obese state is characterized by an abnormal inflammatory response, low antioxidant capacity and reduced insulin sensitivity** that may eventually lead to the generation of inflammation, oxidative stress and insulin resistance. From: [1]

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***Bifidobacterium lactis* BPL1:**

BPL1 is the ADM Biopolis probiotic strain with published clinical data showing improvements in BMI, waist circumference and visceral fat area. Several studies, including in vitro tests, *C.elegans* and murine models, and a human clinical trial in abdominally obese individuals demonstrated the effects of BPL1 on anthropometric adiposity biomarkers [2-5]. After 12 weeks of BPL1 treatment, participants saw a statistically **significant reduction in BMI** compared to baseline and placebo. The results also showed a **significant reduction in waist circumference** (WC) against baseline (1.4 cm) after 6 weeks of treatment with BPL1. This decrease reached 1.75 cm at the end of the treatment [5].

Abdominal visceral fat area also decreased compared to baseline. Overall, 56% of patients in the BPL1 arm had more than a 3cm^2 reduction in visceral fat area. In a recent systematic review and meta-analysis of clinical trials examining the effect of exercise and pharmacological interventions on visceral adiposity, the authors concluded that **losing 3cm^2 of visceral fat was equivalent to 14kg of weight loss from exercise or 18kg of weight loss using pharmacological interventions** [6].

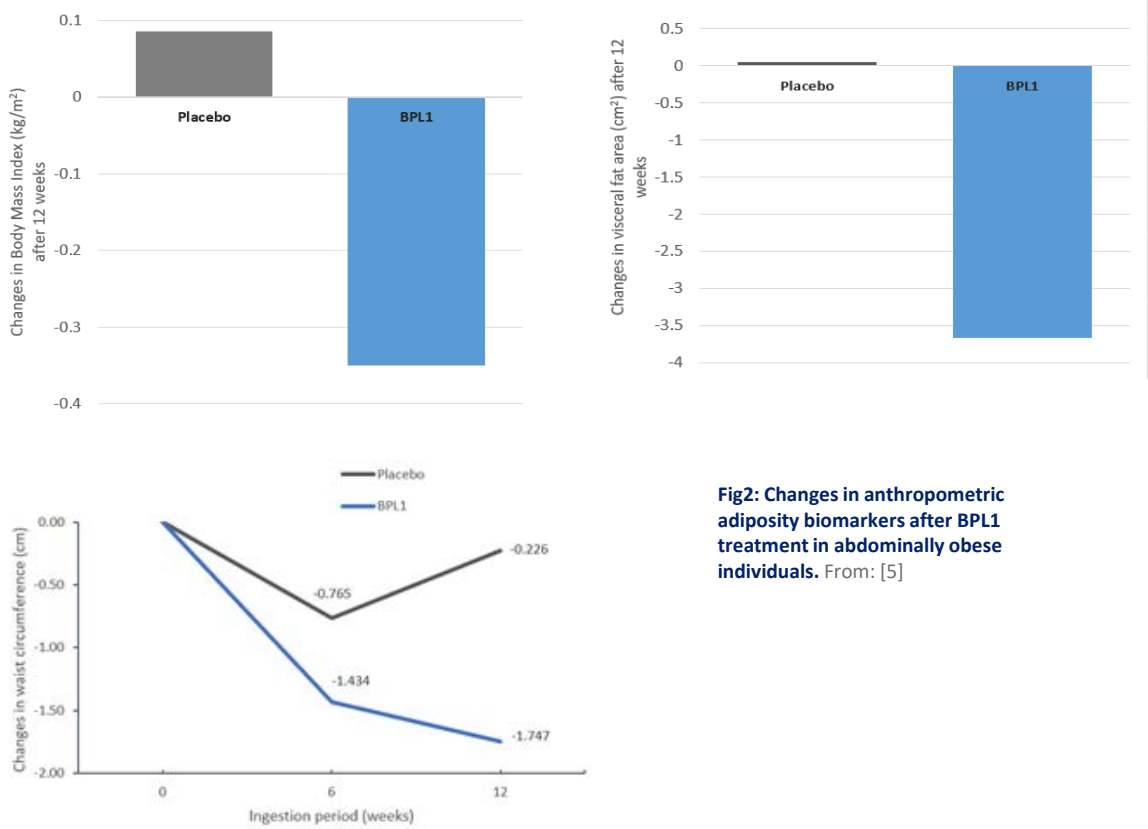

Fig2: Changes in anthropometric adiposity biomarkers after BPL1 treatment in abdominally obese individuals. From: [5]

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What other strains do we add and why?

Lactobacillus rhamnosus CNCM I-4036: with anti-inflammatory support

Obesity is associated with alterations in immunity, a chronic low-grade inflammation in which there are elevated circulating pro-inflammatory cytokines. The excess of macronutrients in the adipose tissues stimulates them to release inflammatory mediators such as tumor necrosis factor α and interleukin 6 (IL-6), and reduces production of adiponectin, predisposing to a pro-inflammatory state and oxidative stress [7]. It has been calculated that one third of total circulating concentrations of IL-6 originate from adipose tissue. Ellulu et al. **linked abdominal obesity with metabolic abnormalities via the inflammatory process** [8]. ; Figure 3 presents their illustration of it:

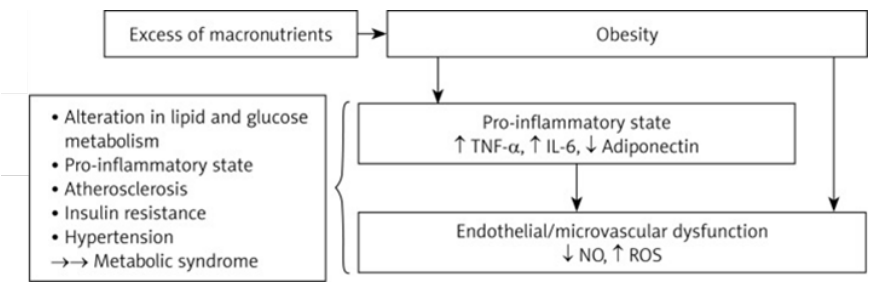

Fig3: Mechanisms linking abdominal obesity and metabolic syndrome via inflammatory mediators. TNF-α – tumor necrosis factor α, IL-6 – interleukin 6, NO – nitric oxide, ROS – reactive oxygen species. – adapted from: [8]

***Lactobacillus rhamnosus* CNCM I-4036** was selected within a large collection of strains isolated from exclusively breastfed babies as the best performant in anti-inflammatory and immune support characteristics. **This strain increased anti-inflammatory cytokines as IL-4 and IL-10 and decreased IL-12 (a pro-inflammatory cytokine)** after 4 weeks of treatment in healthy volunteers. *L. rhamnosus* CNCM I-4036 also significantly improved the IL-10/TNF-α ratio [9]. IL-10 inhibits inflammatory reactions, while TNF-α activates inflammatory reaction locally and systemically. Thus, this ratio is a marker of inflammatory response, and its increase by *L. rhamnosus* CNCM I-4036 indicates a potential anti-inflammatory effect. Moreover, This strain was seen to reduce serum lipopolysaccharides (LPS), (a factor associated with hepatic steatosis) and and diminished the serum profile of proinflammatory cytokines, as TNF-α of obese Zucker rats [10].

In addition, *Lactobacillus rhamnosus* CNCM I-4036 has shown protection against *Clostridium difficile* [9], one the most common causes of infectious nosocomial diarrhoea among adults and strongly related with obesity.

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What other strains do we add & why?

Lactobacillus rhamnosus CECT 8361 (BPL15): demonstrates antioxidant activity

In addition to driving an enhanced pro-inflammatory response, adipose tissue expansion during the progression of obesity can result in excess production of toxic radical species that can cause generation of oxidative stress. Oxidative stress plays an important role in the development of co-morbidities in obesity, including insulin resistance and diabetes, cardiovascular complications, sleep disorders, asthma, oncological problems, reproduction, rheumatological problems, and liver failure (Figure 4). Moreover, oxidative stress could trigger obesity by stimulating the deposition of white adipose tissue (WAT) and altering food intake [11].

Fig4: Conditions generating oxidative stress in the pathogenesis of obesity and the role of oxidative stress in the development of obesity associated health risks. From: [11]

***Lactobacillus rhamnosus* CECT 8361 (BPL15)** significantly increased the survival of the *Caenhorabditis elegans* model organism by more than 30% under oxidative stress compared to control without the strain and its antioxidant activity has been tested on sperm quality from males suffering asthenozoospermia [12]. In this study a decrease in DNA fragmentation and intracellular H_2O_2 levels in spermatozoa due to an antioxidant effect from ***Lactobacillus rhamnosus* CECT8361 (BPL15)** was observed.

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What other strains do we add and why?

Lactobacillus casei CECT 9104 (BPL4): a strain that enhances the effectiveness of the probiotic mixture

Internal analyses performed on the *C. elegans* animal model showed a percentage of fat reduction of 28.8% with respect to standard feeding conditions, as well as an increase in the survival of this model after acute oxidative stress. Thus, the addition of this strain strengthens and enhances the qualities of this probiotic mixture. In addition, *Lactobacillus casei* CECT 9104 (BPL4) presents antagonism against the pathogenic bacterium *Listeria monocytogenes,* one of the most common foodborne pathogen. Recently has been demonstrated that short-term consumption of a westernized diet has the capacity to significantly alter host susceptibility to oral *L. monocytogenes* infection [13].

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